SEMI-ANNUAL REPORT

Summarizing work under Grant

PSYCHOPHYSIOLOGICAL AND PERFORMANCE CORRELATES OF INFORMATION PROCESSING IN SMALL GROUPS

National Aeronautics and Space Administration

Research Grant MGR 44-018-001

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This report summarizes the activity under the following grant: NGR 44-018-001

Submitted by the Division of Psychophysiology, Houston State Psychiatric Institute, Houston, Texas

Approved:

Meil R. Burch, M. D. Co-Principal Investigator

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I. INTRODUCTION

While the initiation date of this grant was 1 January 1965, funding was delayed until 8 March 1965. Change of initiation date was requested 8 March 1965, but the funding agency recommended a no-cost time extension because of the administrative difficulties in changing the initiation date. Both the delay in funding and unanticipated difficulties in check-out of instrumentation have disrupted our proposed schedule so that only now are we fully instrumented for recording analysis and data logging of the galvanic skin response (GSR) on each individual in a three-man group.

The original experimental design proposed called for the group participants to remember what bingo markers had been presented in a given game. Preliminary work indicated that the "recall factor" was overwhelming and made the game almost impossible to play. Consequently, for the first series of initial runs we provided the subjects with a bingo board and a set of checker-like markers. The subjects were allowed to select only one marker per presentation but this change in design made the stimulus sequence and array somewhat inappropriate. However, we have continued to use the set of slides which had been generated for the previous design since the early trials focus on the effect of group structure rather than stimulus field per se.

It has become clear that the individual performance structure as outlined in the proposal is not valid as long as visual communication is allowed between subjects. Subjects seem to tend to compete as members of a "group" even when the monetary reward is strictly a function of individual performance. It is also quite clear that the GSR response of the individual subjects is more a function of non-verbal communication between members of the group than of the bingo slide portion of the stimulus field. In order to accomplish the first aim of the study, to relate psychophysiological responses of the individual to the information content of the stimulus field, we plan to place screens between subjects during the first half of every game. The second half of every game will be played with the screens removed to allow non-verbal communication in the groups.

II. INSTRUMENTATION

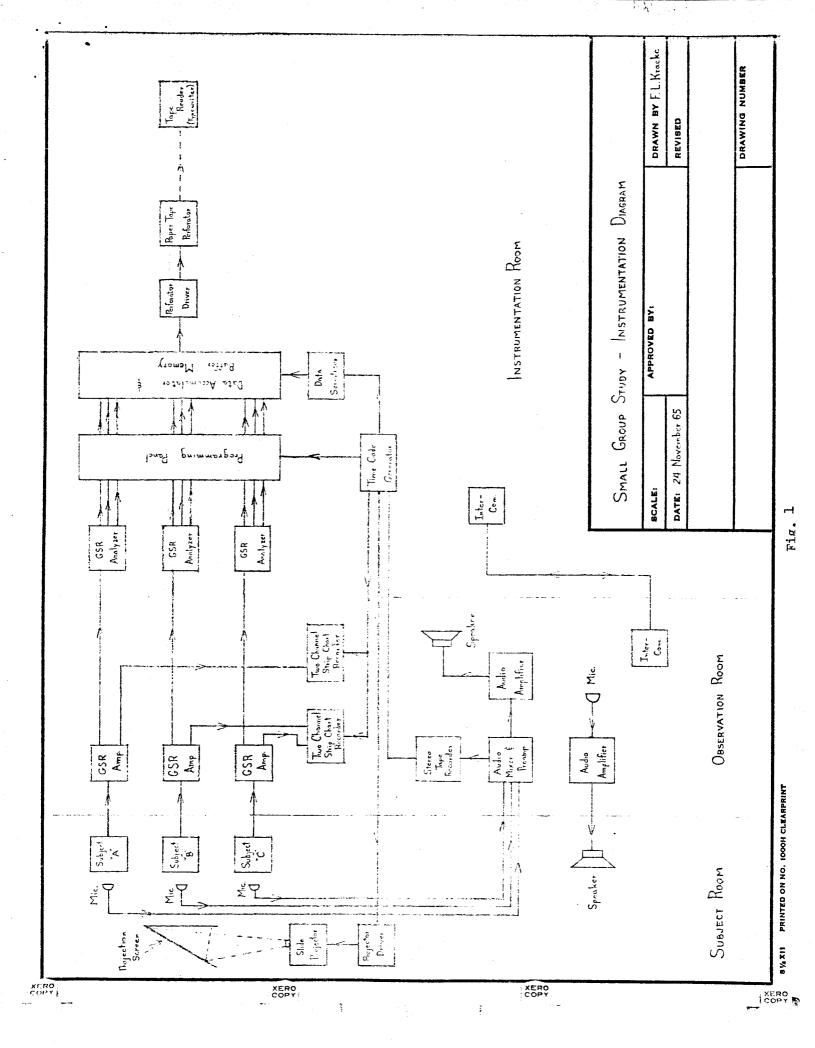
A. Data Acquisition and Processing (Fig. 1)

Silver-silver chloride plated electrodes are applied to each of the three subjects using sodium chloride based electrode paste. A five-eights inch diameter GSR electrode is secured to the middle phalanx of the middle finger of the left hand with a finger cot and a three inch by four inch reference electrode is secured to the left forearm with a two inch elastic bandage.

The electrodes are connected to individual GSR amplifiers in the observation room via a junction box in the subject room. The purpose of these amplifiers is to detect and amplify the GSR. These amplifiers also have a front panel meter which provides a direct reading indication of the basal skin resistance of each subject. The GSR amplifiers each have two outputs; one of which is connected to one channel of a one milliampere strip chart recorder to provide a real time analog record of GSR. The other

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amplified output is sent from the observation room to a GSR analyzer in the instrumentation room. This instrument processes the amplified analog signal and provides three digital outputs. These are GSR amplitude, summed number of GSR's, and GSR onset-to-peak time. The three outputs from each of the three GSR analyzers are then sent through a programming "patch" panel which addresses each of these signals to pre-determined digital storage positions. The number of storage positions chosen for each signal determines the resolution of the system read-out. Which storage positions are chosen for each parameter determines the position of the parameter information in the system read-out.

The digital storage positions are contained in the Data Accumulator and Buffer Memory. Signals from the programming panel are fed into input decimal counters in these units - one counter per storage position. The counters digitally sum the input information over a predetermined time interval. We have elected to use a ten-second sampling epoch. A time code generator provides pulses at ten second intervals to the Data Serializer which in turn supplies processing signals to the Data Accumulator and Buffer Memory. Simultaneously, ten second intervalled pulses are also applied to the time marker pens of the strip chart recorders and through the programming panel into digital storage positions of the Data Accumulator and Buffer Memory to facilitate later comparison of analog and digital records.

At the end of each ten second epoch, a "shift pulse" from the Data Serializer transfers the information content of each input decimal counter in the Data Accumulator and Buffer Memory into a shift register. The input counters are then cleared and continue summing input data from the succeeding epoch. The contents of the shift registers are then serially fed, one at a time, to a Perforator Driver which processes this information into the form required by the paper tape perforator. As each shift register is sampled, it is cleared and thus made ready to receive the information from the following epoch.

The punched paper tape from the Perforator is fed directly into a tape reader-typewriter which supplies an online type-written read-out containing the serial epoch number and summed GSR amplitude, summed number of GSR's, and summed GSR onset-to-peak time for each of the three subjects during each ten second epoch. The punched paper tape is also used later to transfer the punched data to IBM cards for computer processing of the information.

B. Stimulus Field Presentation

The stimulus field is presented to the subjects by projecting dots of light onto a screen with a five-by-five matrix overlay. A standard eighty-one slide magazine type 35 mm. projector is used for this purpose. Slides of the appropriate size were cut from one sixteenth inch aluminum and holes were drilled in each slide corresponding to the programmed array to be presented.

The slide projector is automatically triggered to change slides every ten seconds by a locally designed and manufacture projector driver. This projector driver is synchronized by a triggering palse from the time code

- 2 -

generator at the end of each ten second sampling epoch.

C. Audio System

Conversation between the subjects during the ten minute break between game sequences is monitored and recorded in the observation room. A microphone in front of each subject is connected to an audio mixer-preamplifier in the observation room. The output of this unit is fed to an audio power amplifier and thence to a speaker to permit online monitoring of the conversation. The output of the mixer-preamplifier is also fed to one channel of a four track stereo tape recorder. An audio time code tone from the time code generator at the end of each ten second sampling epoch is recorded on the other channel of the tape recorder. A typed transcript of the conversation between the subjects is later prepared. Time marks are incorporated into this transcript for comparison with the analog and digital records.

Provision is also made for communicating with the subjects from the observation room by means of a separate microphone, audio amplifier and speaker. A simple intercom between the observation room and the instrumentation room enables necessary communication between observer and instrumentation operator.

D. Addition to Instrumentation in Progress

Several additions to the above described instrumentation are presently being installed. One of these additions is a closed circuit television system consisting of two CCTV cameras, a remote control console, an Ampex video tape recorder, and several remote video monitors. Both cameras are equipped with "Zoom" lenses, one of which is remotely controlled electrically. Upon completion of this installation, we will have the capability not only of monitoring the subjects from remote locations other than the observation room, but also of having a permanent video tape record of group behavior during the Bingo games and/or the rest period.

Also being installed is equipment enabling a direct interfacing with the memory units of an IBM 1410 data processing system located elsewhere in the Baylor University College of Medicine buildings. This will afford us the capability of either programming the GSR digital data directly into the 1410 storage units for later data processing or of having online data processing and information feedback to the observer while the experiment is in progress. Another advantage that this installation will afford is an increase in GSR resolution and system sensitivity. Ten second sampling epochs have been chosen because this was the time limitation imposed by the mechanical limits of the paper tape punch. Direct access to high speed 1410 data processing system storage units will permit high scan rates of the Data Accumulator and Buffer Memory by the Data Serializer with a consequent decrease to the incremental level of data sampling epochs.

E. List of Equipment Used

Quantity	Nomenclature
l ea.	Kodak Carousel 800 35 mm. slide projector
l ea.	Projector Driver
3 ea.	GSR Amplifier, Model 201 - Bio-Physical Research Instruments, Inc.
2 ea.	Dual Rectiwriter 1 ma. strip chart recorder - Texas Instruments, Inc.
l ea.	Sony Professional Sterecorder Model 777S Tape Recorder
l ea.	Harman Kardon Galaxy Audio Mixer-Preamplifier
l ea.	Bell Model 5630 Audio Amplifier
l ea.	H.H. Scott Type 222C Stereo Laboratory Amplifier
3 ea.	GSR Analyzer, Model 106
l ea.	Digital Data Logging System, Model 901,
	Programming Unit.
5 ea.	Data Accumulator and Buffer Memory
l ea.	Time Code Generator, Model 802
l ea.	Data Serializer
l ea.	Perforator Driver
l ea.	Friden Auxiliary Punch, Model 2 (Paper Tape Punch)
l ea.	IBM 1050 Teleprocessing System (Tape Reader and Typewriter)

III. SUBJECT POPULATION

All subjects have been white males between the ages of 18 - 30 taken from University and Medical School student groups. All but one had no previous direct exposure to the experimental situation. Galvanic skin responses were recorded on all subjects throughout the entire run including the rest periods between game sequences. Both analog and digital records of individual GSR's were obtained together with an audio tape recording of all verbalizations. However, digital data recordings at this stage have been made for the sole purpose of instrumentation check-out and procedure standardization. No attempt has as yet been made to further process and valuate this data.

IV. BINGO GAME INSTRUCTIONS AND PROTOCOL

Prior to the commencement of each game, GSR electrodes were applied to each subject, and the subjects were then seated at tables facing the projection screen. On the table in front of each subject was a Bingo Card divided into twenty-five equal squares corresponding to the five-by-five matrix overlay on the projection screen. The squares on the Bingo Cards, however, were sequentially numbered from left to right starting in the upper left-hand corner. Each subject was also equipped with a supply of markers to be used during the games for covering the numbers of his choice.

After being connected to the GSR instrumentation, the subjects were instructed in the rules of the game. These instructions were given verbally

- 4 -

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on the first five runs. On the sixth run, however, each subject was given a set of written instructions. A copy of these instructions is appended to this report, and is essentially a verbatum account of the instructions given verbally to the first five groups.

Each game was divided into two sequences with a "rest" period between sequences. Verbal communication was sometimes permitted and sometimes forbidden during this rest period. The slide magazine of the Carousel projector used has an 81-slide capacity. These 81 slides contain a sufficient number of arrays for six separate trials. These six trials are repeated three times for a total of eighteen trials per sequence. Two such sequences (36 trials) completed a run.

Each trial comprised the presentation of a variable number of slides and each slide presented either 1, 2, or 3 dots of light onto the screen. When presented with a slide the subject was instructed to choose one of the squares (indicated by a dot of light) and to record his choice by covering the corresponding square on his board with a marker. Where only one dot appeared on the screen, his choice was obvious; but where two or three dots appeared, he had to choose just one. "Bingo" was won if, by making a correct choice each time during the trial, all squares in a given column or line were occupied by markers.

Three observer-scorers were seated at a one-way window in the observation room adjacent to the game location and each observer was furnished with a score sheet and instructed to score the choices of the subject assigned to him. A copy of a score sheet is attached to this report. As each subject made his choice and covered the appropriate square with a marker, the scorer recorded the number of this square on the sheet. He also made a record of all bingos attained by his subject. In games where individual performance was rewarded, twenty-five cents was paid to each subject for a correct bingo. In games where group performance only was rewarded, twenty-five cents was paid to each subject only if all three succeeded in completing a bingo, ("group performance" configuration).

V. DETAILS OF TRIAL RUNS

A. Trial Run No. 1

This run involved only two subjects. Its primary purpose was for the initial check-out of inter-room conduit wiring and equipment installation complete at that time. Provision for the monitoring of a third GSR were still being installed. This run was also used as a trial for the modified game configuration utilizing the Bingo cards to eliminate the recall factors.

The subjects were rewarded on an individual performance basis and were instructed that there was to be no verbal communication during the rest period between sequences. Unfortunately, the no-verbal communication discipline was broken by the necessity of having to enter the subject room during the rest period to make necessary technical adjustments. There was, however, no communication pertaining to the Bingo game itself, so it is felt that both

- 5 -

subjects were still playing as individuals during the post rest period sequence of trials.

Both analog and digital GSR data recordings were made as well as an audio tape recording of all rest period communication.

The final scores were as follows: (Scores are stated here and in all the subsequent trial descriptions as the number of Bingos scored by a subject during an 18 trial sequence.)

	Pre-rest period	Post-rest period
Subject A	11	11
Subject B	10	13

B. Trial Run No. 2

The second trial run utilized three subjects for the first time. Performance was rewarded on a "group performance" basis. That is, a reward was given to all the subjects if and only if all three subjects simultaneously scored a Bingo on a given trial. Instructions were issued verbally by the observer in charge. Use was made for the first time of a visual aid device consisting of a sample trial presentation (not duplicating any of the trials subsequently to be played) to demonstrate the mechanics of playing the game. Verbal communication between the subjects during the rest period was encouraged. It was noted on this trial that a rest period of five minutes was too short for the development of effective discussion among the subjects. The instructions explicitly forbade the subjects from copying from each other inasmuch as there was no partions erected between the subjects to implictly prevent this. The final scores were:

	Pre-rest period	post-rest period
Subject A	7	11
Subject B	10	10
Subject C*	12	18

Total group "Bingo's" (i.e., Bingo's scored simultaneously by all three subjects) were 13 out of a possible 36.

C. Trial Run No. 3

Once again, three subjects were utilized during this run. Free verbal communication during the rest period was encouraged and rewards were again made on the basis of group performance. The rest period was extended to ten minutes; good group interaction was observed at this time. Analog GSR records

^{*} Subject C was a last minute substitute who had previously been a scorekeeper in a trial run and therefore was familiar with the game.

were obtained for this run, but no digital information was recorded because the digital data logging system was undergoing some modification and improvement at this time. The scores for this run were:

	Pre-rest period	Post-rest period
Subject A	9	8
Subject B Subject C	9	13

Total group Bingo's were 9 out of 36 possible.

D. Trial Run No. 4

Verbal instructions were given to all three subjects and rewards were again made on the basis of group performance. Free verbal communication during the rest period was encouraged, and for the first time the subjects were implicitly permitted to copy from one another. That is, there was purposely no specific instruction forbidding this practice. During the rest period, the subject group spontaneously "elected" a leader and followed his example throughout the entire post rest period sequence. This accounts for the identical scores during this sequence as listed below. Toward the end of the sequence game, the two "followers" were clearly losing interest and merely followed the leader mechanically. The results were as follows:

	Sequence 1	Sequence 2
Subject A	6	14
Subject B	10	14
Subject C	9	14

Three group Bingo's were scored during the Pre-rest period sequence and fourteen were scored during the Post rest period sequence, totalling seventeen out of a possible 36 group Bingo's.

E. Trial Run No. 5

The game configuration for this run was identical with that of Run No. 4. That is, the three subjects were issued instructions verbally, rewards were made on the basis of group performance, free communication during the rest period was encouraged, and no prohibition of copying was made.

There was much spontaneous discussion time the instructions were issued and the actual start of the Pre-rest period sequence as to what "system" to adopt. One subject suggested copying, and all three appeared to be doing this at first, but abandoned it later during the first sequence. During the rest period, one of the subjects revealed that he had discovered the cyclic effect of the trial presentation and he appeared to assume a tacit leadership of the discussion. During the rest period, experimental discipline was broken because one subject had to leave the subject room and adjustments had to be made on the ground electrodes of the other two subjects. This group ingeniously got around the prohibition against verbal communication during the actual presentation of the Post rest period sequence by the

- 7 -

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liberal use of hand signals and other such devices. By means of these devices the subjects seemed to arrive at a consensus as to the choice for marker placement for each slide. No one subject was a leader in the actual playing of the game. The results for this group were:

	Pre-rest period	Post-rest Period
Subject A	7	14
Subject B	3	15
Subject C	14	14

with a total of 17 group Bingo's out of a possible 36.

F. Trial Run No. 6

As a means of standardizing the instructions given to each of the subject groups, a set of written instructions was prepared to be given to each subject prior to a run. This was the first group to use those written instructions. Also, for the first time, screens were erected between the subject's tables to shield each subject's Bingo card from the view of his two fellow players. This device implicitly prohibited copying. The subjects themselves were not shielded from each others view so non-verbal communication was possible. Again, reward was made on the basis of group performance, and free verbal communication during the rest period was encouraged.

This run presented us with our first instance of population contamination. One of the subjects had acquired prior information from a previous subject. How much prior knowledge he had is not known, but he was aware that there would be no Bingo's on a corner to corner diagonal and he conveyed this fact to the other players prior to the run at a time when he felt assured that no examiner was present. This subject may also have known of the cyclic nature of our trial presentation because he was observed recording the column and row numbers of the various Bingo's in pencil on the table top during the pre-rest period sequence as a memory aid. He was asked to erase this information during the rest period.

Only seventeen trials were presented during the pre-rest period sequence. At the end of the seventeenth trial, the projector lamp burned out. However, the subjects were not informed that the sequence had been shortened by one trial, and the run was continued normally.

The observer entered the subject room during the rest period, and it is felt that his presence inhibited conversation between the subjects. Verbal interaction was whispered at the time and was not recordable.

Scores	during this run were:	Pre-rest period	Post rest period
	Subject A	9 (out of 17)	15 (out of 18)
	Subject B*	13 (out of 17)	13 (out of 18)
	Subject C	11 (out of 17)	10 (out of 18)

for a group performance total of 16 out of 35 possible.

^{*}Subject B was the subject with prior information.

VI. PROPOSED SCHEDULE

The next cycle of subjects will be started approximately 15 January 1966. In this second cycle the first half of every game will be structured so the subjects respond to the information content of the stimulus field as individuals usually isolated from other subjects. The second half of every game will be structured in a stronger group relationship than was utilized in the first cycle. This strong group relationship was described as "fourth level of group participation" in the original proposal and consists of the assignment of a control decision to one subject in the role of "commander" in which he is able to evaluate and select the performance of the other subjects in terms of the contribution of their performance to the group score.

Automatic GSR analysis and data logging instrumentation will be completed and utilized throughout the second cycle.

Automatic stimulus field presentation and performance scoring will be developed during this second cycle.

The stimulus field program will be changed to obviate the strong learning effect which has become apparent in the results from the first cycle of subjects.

Efforts will be made to develop a "communication model" of information transfer between the "commander" and the other two subjects based on performance profiles during the second half of the group.

VII. APPENDICES

- A. Bingo Game Instructions
- B. "Bingo Game" Scoring Sheet

-9-

APPENDIX A.

BINGO GAME

INSTRUCTIONS

This afternoon you will be playing a version of the parlor game Bingo. On your desk you will find a "Bingo Card" containing twenty-five numbered squares, as well as a supply of markers. On the other side of the room, in front of your desk, there is a projection screen marked off with twenty-five squares corresponding to the numbered squares on your Bingo Card.

During the game, dots of light will be projected onto the squares on the screen. Each presentation will last ten seconds, and will consist of one, two or three dots. If one dot is shown, take one of your markers and place it in the corresponding square on your Bingo card. If two or three dots are shown, you must choose which one of the dots will most likely enable you to get five markers in a row on your Bingo card. Make your choice, and then place a marker on your card. Do not move the markers once you have placed them on your card. When you already have markers on all the squares in which dots are presented, just skip the turn and wait for the next presentation. If, after a sequence of presentations, you have five markers in a row on your Bingo card, you will have scored a "Bingo". This is the object of the game. The presentation after you complete a Bingo will show the five dots in a row on the screen, thus indicating that you are right. If a presentation of five dots in a row is shown and you do not have five markers in a row on your card, then you have missed the Bingo. In either case, the five dot presentation indicates that a game is completed. When you see it, whether you have a Bingo or not, clear all the markers off

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BINGO GAME INSTRUCTIONS (CONTINUED)

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your board and be ready for the next presentation, which will be the start of a new game.

Your score will be kept by a scorekeeper watching your card through the window behind you. The scorekeeper will make a note of each choice you make. For this reason, do not lean across your desk or otherwise obscure your Bingo card from the scorekeeper's view. Also, in order to allow the scorekeeper to be sure whether you have a Bingo or not, do not clear your card too quickly when the five dot presentation is shown. Wait for several seconds, and then clear the markers off your card.

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BINGO GAME

SUPPLEMENTARY INSTRUCTIONS

This afternoon you will play a series of Bingo games which will last for about forty-five minutes, after which you will be given a ten minute break to relax a little. Following the break you will play another forty-five minute sequence of games.

During the games themselves, there will be no talking. However, during the break, this restriction is, of course, lifted. If you wish to talk with your fellow players about the game, you are free to do so. Your electrodes will not be disconnected during the break. Therefore, please do not leave your seat. Your conversation during the break will be monitored and recorded by the scorekeepers.

There is a twenty-five cent prize to each player for making a Bingo, but there is a catch. To win this prize, you and both of your fellow players must all three make the Bingo for that game. If only one of the three of you does not make the Bingo, then no one wins the prize.

Relax and enjoy yourself. And good luck.

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NASA SMALL GROUP STUDY "BINGO GAME"

page 1.

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